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REVIEW OF THE TORTUGAS PINK SHRIMP FISHERY FROM MAY 1985 TO DECEMBER 1986

By

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INTRODUCTION

The Gulf of Mexico Shrimp Fishery Management Plan established an area commonly known as the Tortugas shrimp sanctuary off south Florida in May 1981 (Fig. 1). The goal of the Gulf of Mexico Fishery Management Council in establishing the sanctuary was to protect small, undersized shrimp from being fished and to increase and optimize the overall poundage yield from the fishery. This decision was based on scientific evidence that showed the sanctuary area to be the nursery ground for the Tortugas stock of the pink shrimp Penaeus duorarum, and that the poundage yield of offshore pink shrimp would be greater if harvest was delayed until shrimp were larger than minimum legal size in Florida (69 tails per pound) (Lindner, 1965; Berry, 1970). Since May 1981, the whole sanctuary has been closed to trawling, with the exception of a small region locally known as the "toe area", which was reopened for a brief period (April 1983 through August 1984) to evaluate the effects (Klima and Patella, 1986).

This paper reviews the characteristics of the Tortugas fishery from May 1985 to December 1986 and compares results with historical data. Deviations from historical averages are discussed in light of the established sanctuary. Current trends with regards to the Tortugas fishery also are discussed.

METHODS

Fishery Data Statistics

Collections of detailed catch statistics describing the Gulf of Mexico shrimp fishery in United States waters since 1956 are compiled by and available from the Southeast Fisheries Center (SEFC)/Office of Economics and Statistics (ESO). The procedures used to collect them have been described by Klima (1980). These statistics consist of catch, recorded as pounds of shrimp (heads-off); fishing effort, recorded as either 24 hours of actual fishing time or number of trips; and size composition of catch, expressed in eight "count" or size categories representing number of shrimp

tails per pound (<15, 15-20, 21-25, 26-30, 31-40, 41-50, 51-67 and ≥68).

These statistics were grouped and analyzed by biological year (May through April) and used in this report to determine the effects of the Tortugas shrimp sanctuary on the fishery. These statistics were also used to calculate other useful values such as catch per unit effort (CPUE), expressed as pounds per 24 hours of fishing, and average number of shrimp per pound. All statistical tests utilized in the report are described in detail by Nance et al. (1986).

RESULTS

Landings

Annual landings by biological year, May 1960 to April 1985, in statistical subareas 1 through 3, have averaged approximately 9.8 million pounds yearly (Fig. 2). Pounds landed have fluctuated from a high of 13.4 million pounds in 1960 to a low of 6.9 million pounds in 1983. Yet, even with this 6.5 million pound range, the fishery has remained relatively stable throughout this 26 year period. The standard deviation around the historical mean was only ± 1.7 million pounds, with a value of 17% for the coefficient of variation. Only during biological years 1960, 1965, 1971, 1982 and 1983 have yearly landings fallen outside one standard deviation of the mean. During biological year 1985, about 8.4 million pounds of pink shrimp were landed from statistical subareas 1 through 3 (Fig. 2). This value was below the historical mean of 9.8 million pounds, but still within one standard deviation of the mean.

Estimates of pink shrimp landings during biological year 1986 were very low in comparison to the historical average and all other years since 1960. The estimated landings for 1986 (May 1986-April 1987) are around 5.7 million pounds, which would make 1986 the worst year on record. Only actual landings from May 1986-December 1986 are available on computer, but tentative figures from January 1987-April 1987 were gathered from port agents in the area. Only landings were estimated, so statistics such as effort, CPUE, and size composition will only be reported for the first

eight months of biological year 1986.

The monthly pattern of shrimp landings in biological year 1985 and the first 8 months of biological year 1986 (May 1986 through December 1986) were compared with historical monthly averages (Fig. 3). During biological year 1985, most catches during the summer and fall were similar to or slightly above the historical average for the month. All winter months (October through February) showed below average values, but none were significantly different from their respective historical average. Landings during the spring months (March and April) were near the average value recorded for those months.

A dramatic decrease in pounds landed has been noted during the first 8 months of biological year 1986, with only July having an above average catch. Values recorded for October through December were significantly below average. Estimations of pounds landed for the other four months of biological year 1986 depict a similar trend when present values were compared to historical values month.

Fishing Effort

Fishing effort by biological year, May 1960 to April 1985, in statistical subareas 1 through 3 has averaged 16,000 days per year with a standard deviation of $\pm$ 2,300 days per year (Fig. 4). The coefficient of variation was 14%. The small standard deviation and low coefficient of variation are good indicators of the stability of this fishery. Even so, effort has fluctuated from a high of 22,000 days expended in 1960 to a low of only 11,000 days fished in 1979. Fishing effort reported for biological year 1985 was about 13,000 days, which is below average, but only slightly below one standard deviation of the historical mean. Only three other years, 1976, 1979 and 1981 have also been below the one standard deviation from the mean level.

The monthly pattern of fishing effort in biological year 1985 and the first 8 months of biological year 1986 were compared with historical monthly averages (Fig. 5). Above average fishing effort values were noted during most of the early months of biological year 1985. Efforts values

fell below average during the remainder of biological year 1985, but only values from February were significantly below average. This decreased effort carried into biological year 1986 with only August having an effort value greater than its historical counterpart.

Relative Abundance

The relative abundance of pink shrimp, as expressed by catch per unit effort (CPUE), is reported as pounds caught during a 24 hour fishing day (pounds per day). The annual CPUE at the Tortugas fishing grounds has been a very stable parameter over the last 25 years. CPUE values have averaged about 610 pounds per day with a standard deviation of around 87 pounds per day (Fig. 6). This has resulted in a coefficient of variation value of 14%. The highest historical CPUE recorded was close to 800 pounds per day during biological year 1981 and the lowest CPUE was 505 pounds per day, which occurred during biological years 1982 and 1983. The annual CPUE value during biological year 1985 was a little higher than average at 639 pounds per day.

Even though annual CPUE values for the past 26 years have not varied considerably, large variations have been noted in monthly CPUE values (Klima et al., 1986). Thus, a large standard deviation value is found around each monthly historical mean CPUE value. Monthly CPUE values for biological year 1985 and the first 8 months of biological year 1986 were compared with their respective monthly historical mean value (Fig. 7). All months, except four during biological year 1985, had above average CPUE values compared with their historical average. The exceptions were August, October, November and April. However, none differed significantly from their respective historical average CPUE value.

CPUE values were below average during 7 out of the 8 months analyzed during biological year 1986. Only June had an above average value. This below average trend also appeared to carry into the last four months of biological year 1986.

In comparing the the monthly CPUE values with the historical data, we also plotted a ratio of the monthly CPUE values from May 1981 through

December 1986 over the historical monthly CPUE values (Fig. 8). These values showed that for the 3 months of greatest catch (December, January and February) that biological year 1985 (December 1985-February 1986) was very similar to biological year 1984 which had above average production. Also, it was noted that the low values experienced during the first 8 months of biological year 1986 (May 1986-December 1986) were similar to values for the same periods in low production years such as biological year 1982 (May 1982-December 1982) and biological year 1983 (May 1983-December 1983).

Recruitment

Recruitment of pink shrimp onto the Tortugas fishing grounds usually occurs during two periods in a calendar year. The first recruitment takes place from March through May, with a second recruitment from August through October. In the past, the pounds of pink shrimp landed and the average size of pink shrimp measured by the size categories of the ESO have been used as an indicator of recruitment on the Tortugas grounds during certain months (Klima et al., 1986). Specifically, if the landings for a selected month exceeded the historical average and if the average weighted mean size for that month was greater than the historical average, the recruitment was termed "good" or "better than average" for that month. Although this method showed correlation between good recruitment and above average landings in some years, in most cases it failed to show any correlation. Either good recruitment with poor catch was noted, or lack of recruitment was shown during a year with an outstanding catch.

Utilization of landing data by size class composition, as stated above, is the best method to show recruitment into the fishery, but all months must be analyzed to draw correct conclusions from the data. Analysis of data may be shown as either percent composition of each size class, or just expressed as actual pounds caught by size class. With either method, recruitment is indicated whenever a high percentage of the catch or a large poundage figure is in size class group number 8 ($\underline{>}$ 68 tails per pound). However, when using percent composition figures to determine recruitment,

caution must be used in interpretation of results. Data expressed as percent composition by size classes must not only be carefully correlated with actual pounds caught to determine intensity of recruitment, but it must also be checked to determine if recruitment was masked by high percentage values in other size classes.

Periods where recruitment has occurred were easily observed when analysis was performed by actual pounds caught for a given size class (Fig. 9). Recruitment periods in biological year 1985 where May, September and March through April. Note that during biological year 1986, no periods of recruitment can be seen. As will be discussed later, this appears to be the reason for the poor season experienced during that year.

Size

The size of shrimp landed may be used to identify change that may have occurred due to fishing. If the management measure of prohibiting trawling in the sanctuary was effective and restricted the capture of small shrimp, we would expect the size of shrimp to increase and therefore be different than the historical average sizes. During the period, part of the Tortugas sanctuary (the toe area) was opened to fishing for comparative purposes many small shrimp were caught (Table 1). Once this area was closed again, mean number of shrimp per pound decreased abruptly. Thus, small shrimp (50-60 count) were caught in great abundance during that open period while larger sized shrimp (35-45 count) have been caught thereafter (Fig. 10). The only major exceptions have occurred during September 1985 and March 1986, when small shrimp were caught as they moved onto the grounds from the sanctuary during normal recruitment migration.

DISCUSSION

The Tortugas fishery has been very stable over the past 26 years. Evaluation of annual historical data showed very low coefficient of variation values for landings (17%), fishing effort (14%), and CPUE (14%). The fishery is bounded naturally by untrawlable bottoms of loggerhead

sponges and coral reefs where pink shrimp are protected from trawling activities, even though they may be present in high concentrations. This large area of untrawlable bottom surrounding the fishery grounds may be one reason why this fishery has been so stable since 1960. It is interesting to note that the Sanibel area (statistical subarea 4) has followed similar annual trends.

During biological year 1985, pounds landed and effort values were below their respective historical average while CPUE was slightly above its historical average. Pounds of shrimp landed were around 8.4 million pounds, with a fishing effort value of about 13,000 days. This computed to a CPUE value of 639 pounds per day fished. However, none of the three catch statistics were significantly different than their historical average. As noted in previous years, most pink shrimp were caught in relatively shallow water.

The offshore pink shrimp fishery discussed thus far is directly dependent on young shrimp migrating in large numbers from nursery areas onto the fishing grounds. If these small shrimp are caught early, maximum yield in the fishery is not attained. The permanent closure of the Tortugas sanctuary was established in May 1981 to prevent the capture of these small shrimp in the nursery areas and thus maximize the yield. As stated earlier, the whole sanctuary has been closed to trawling since that time, with the exception of the toe area, which was reopened for a brief period (April 1983 through August 1984) to evaluate the effects. A report by Klima and Patella (1986) showed an increase in the number of small shrimp caught during the period the toe area was opened. With the reclosure of the entire sanctuary to shrimping activities, size ratio values (average monthly size divided by historical monthly size) have again decreased (Fig. 10). Small shrimp being recruited to the offshore fishery were rapidly harvested when the toe area was opened, but small shrimp were able to increase in size and then enter the fishery when the toe area was closed (Table 1). Thus, the overall objectives of the closure, to increase the size and optimize the yield of the shrimp moving onto the fishing grounds by preventing the capture of small shrimp in the nursery areas, seems to

have been met with the Tortugas sanctuary.

The Tortugas sanctuary does prevent the capture of small shrimp and optimize the yield of the shrimp moving onto the fishing grounds. Yet, shrimp must be available to the system if the management measure is to work. Thus far, during biological year 1986 no recruitment of small shrimp from the nursery areas has been observed. If estimates are correct, then biological year 1986 will be the worst year with regards to pink shrimp landings on record. This lack of recruitment onto the fishery is graphically observed when CPUE values for small shrimp were plotted by month (Fig. 11). National Marine Fisheries Service Galveston Laboratory is currently developing a catch prediction model for the Tortugas area which is exploring the possible environmental factors controlling the fishery.

Illegal trawling inside the Tortugas sanctuary did not seem to be a problem during biological year 1985. Only 5 boats were ticketed during calendar year 1986 (Steven Springer[1]). It appears that violations have decreased appreciably with the increased enforcement capability in the area.

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[1]Steven Springer, Personal Communication, Southeast Regional Office, Law Enforcement Group, 9450 Koger Blvd., St. Petersburg, FL 33702.

SUMMARY

1. Commercial pink shrimp landings from the Tortugas fishery (statistical subareas 1 through 3) have been relatively stable for the past 26 years. Average catch has been 9.8 million pounds per year with a standard deviation of ± 1.7 million pounds per year. Pink shrimp landings during biological year 1985 were just over 8.4 million pounds. During the first 8 months of biological year 1986 (May 1986 through December 1986), 2.4 million pounds were landed. This value represents a 48% decrease when compared to the first 8 months of biological year 1985, which had 4.6 million pounds landed.

2. Fishing effort for pink shrimp on the Tortugas grounds have averaged 16,000 days annually for the past 26 years with a standard deviation of ± 2,300 days. During biological year 1985, 13,000 days of fishing were expended in the Tortugas fishery. For the first 8 months of biological year 1986 (May 1986 through December 1986), effort was 5,480 days. This value represents a 23% decrease in effort when compared to the first 8 months of biological year 1985, which had an effort value of 7,160 days.

3. CPUE (pounds per day fishing) has been the most stable parameter over the past 26 years at the Tortugas fishing area. The historical average has been 610 pounds per day with a standard deviation of only ± 87 pounds per day. The CPUE value for biological year 1985 was 639 pounds per day. During the first 8 months of biological year 1986 (May 1986 through December 1986), CPUE was 460 pounds per day. This value represents a decrease of 28% when compared to a value of 640 pounds per day for the first 8 months of biological year 1985.

4. Two extended periods of high recruitment of small pink shrimp into the Tortugas fishing grounds were noted during biological year 1985. Fall recruitment was in September and spring recruitment was from March

through April. No periods of recruitment have been observed during biological year 1986.

5. Illegal trawling inside the Tortugas sanctuary was not viewed as a problem during biological year 1985.

6. During biological year 1985 the Tortugas sanctuary had a positive impact on the Tortugas fishery. Larger numbers of smaller count shrimp (larger shrimp) were caught during biological year 1985, when compared to the historical average. The monthly average shrimp size was larger, when compared to historical monthly shrimp size, for all months except March 1986. This indicates that the closure restricts the capture of small shrimp.

7. We conclude that the Tortugas closure has met the objectives of the Gulf of Mexico Shrimp Fishery Management Plan to protect small shrimp and thus increase yield in the Tortugas pink shrimp fishery. Yet, this management effort will only be successful if there is recruitemnt of small shrimp into the fishery. During biological year 1986 this has not occurred and all indications point to 1986 as being the worst year on record with regards to catch, effort and CPUE. All three 1986 values showed a decrease even when compared to the below average values experienced in 1985 (catch down 48%, effort down 23% and CPUE down 28%).

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Table 1. Monthly average weighted number of pink shrimp per pound for 1960-79, 1981, 1982, 1983, 1984, 1985 and 1986 (+ indicates larger size group and - indicates smaller size group than historical average; bracketed portion indicates open fishing in toe of the boot).

Months	1960-1979 Average Number/lb	1960-1979 Standard Deviation	1981 Average Number/lb	1982 Average Number/lb
May	46.8	5.1	57.4 +	48.4 +
June	45.2	4.5	52.7 +	45.7 +
July	44.0	4.7	44.2 +	36.6 -
August	44.0	7.7	38.9 -	55.0 +
September	48.7	7.9	47.5 -	49.0 +
October	47.9	4.8	41.4 -	43.3 -
November	43.1	3.3	36.4 -	41.3 -
December	40.2	2.8	34.9 -	39.3 -
January	40.2	3.1	35.6 -	43.6 +
February	42.7	3.1	42.1 -	48.0 +
March	47.5	4.4	46.8 -	57.5 +
April	48.3	5.8	49.8 +	[54.1 +]

Months	1983 Average Number/lb	1984 Average Number/lb	1985 Average Number/lb	1986 Average Number/lb
May	56.8 +	[55.9 +]	42.4 -	38.9 -
June	50.2 +	[53.1 +]	42.1 -	45.3 +
July	58.0 +	[55.0 +]	42.1 -	42.0 -
August	49.6 +	[46.9 +]	33.5 -	39.4 -
September	44.2 -	36.9 -	55.3 +	40.2 -
October	44.0 -	45.8 -	45.9 -	38.9 -
November	36.6 -	41.0 -	33.0 -	43.0 -
December	36.1 -	35.2 -	35.6 -	39.0 -
January	49.4 +	38.0 -	37.3 -	
February	48.1 +	39.8 -	40.1 -	
March	58.7 +	40.5 -	51.1 +	
April	60.5 +	44.2 -	48.4 +	

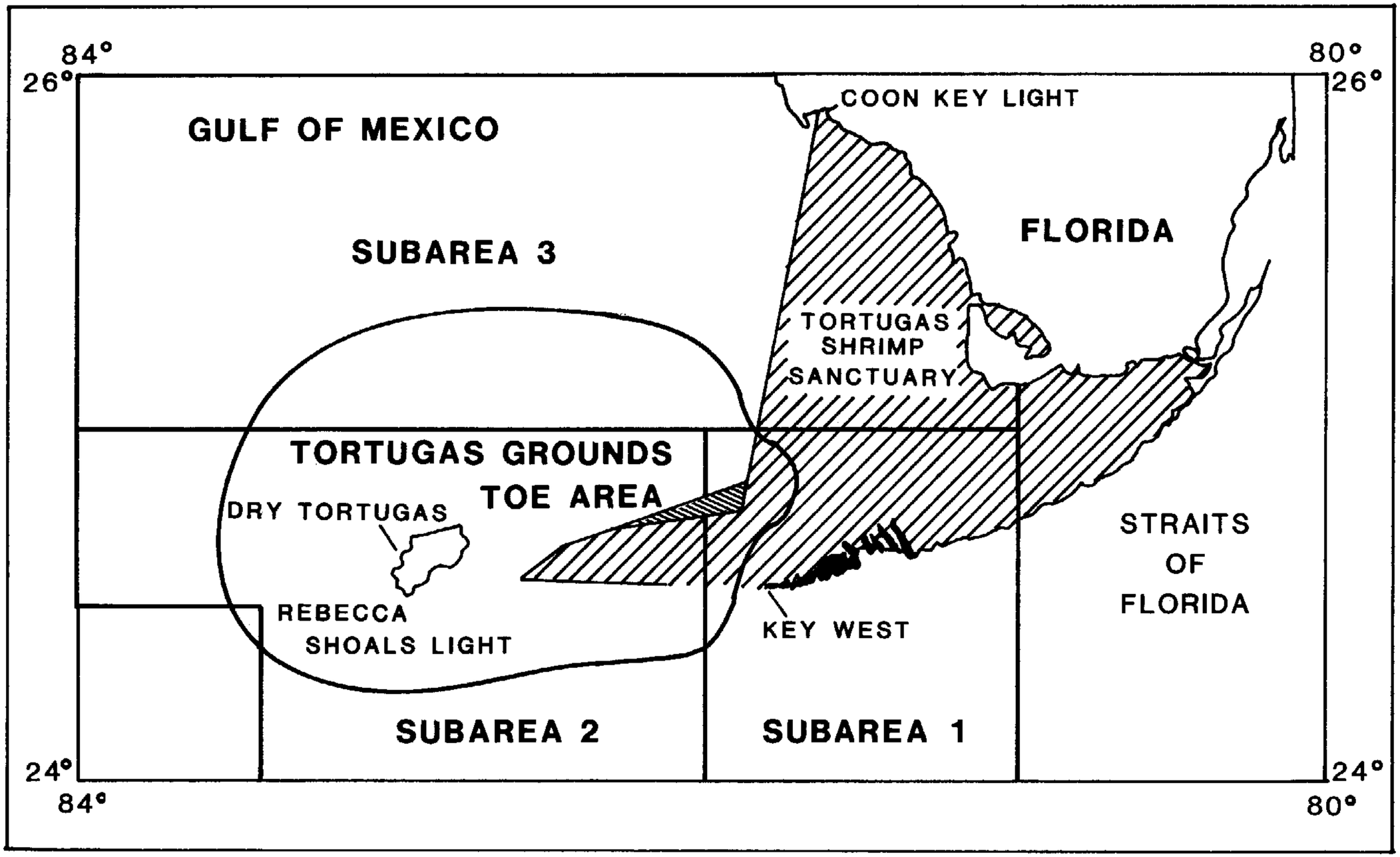

Figure 1. Map of the Tortugas fishing grounds and statistical subareas.

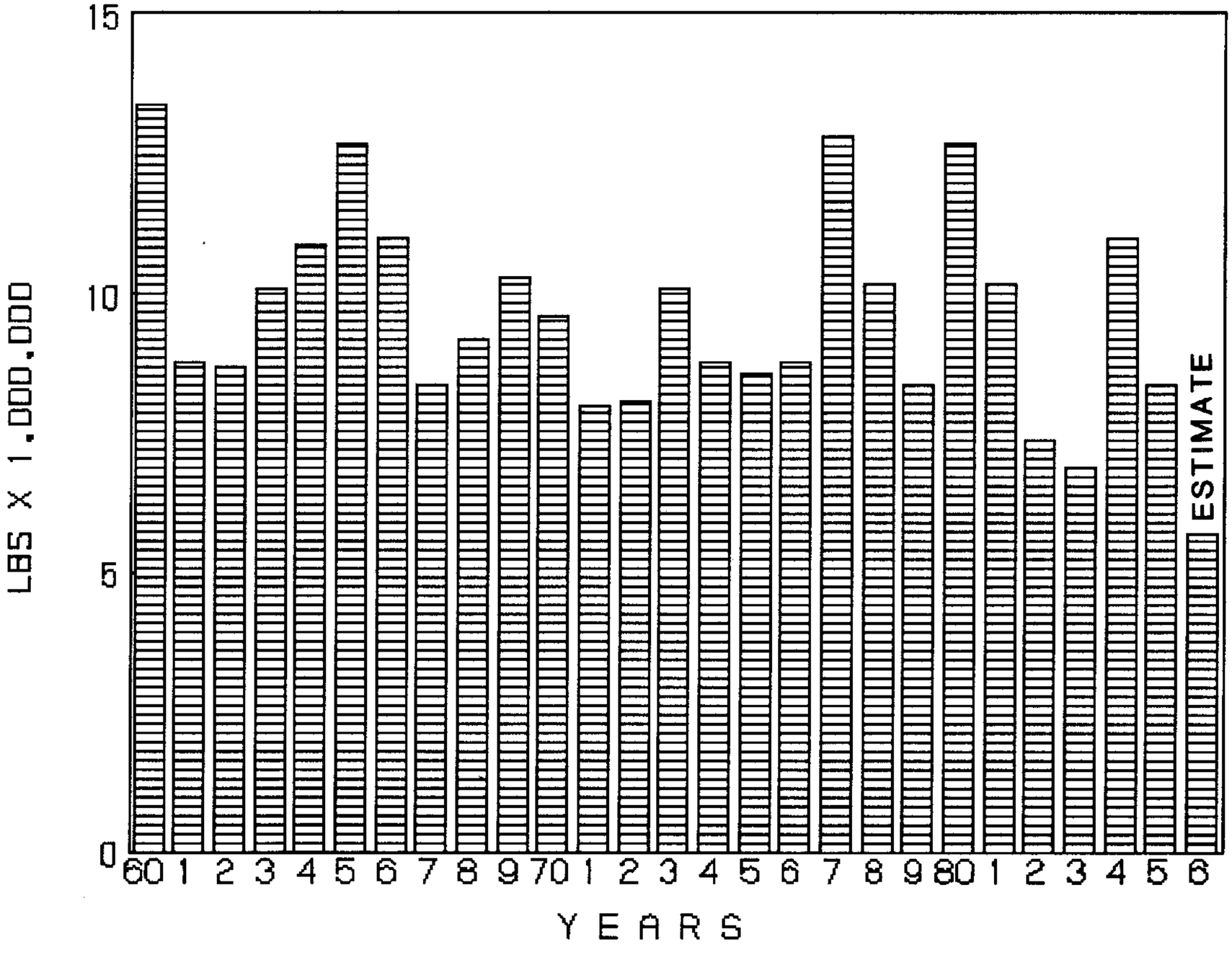

Figure 2. Annual pink shrimp landings from the Tortugas grounds for biological years 1960 through 1986.

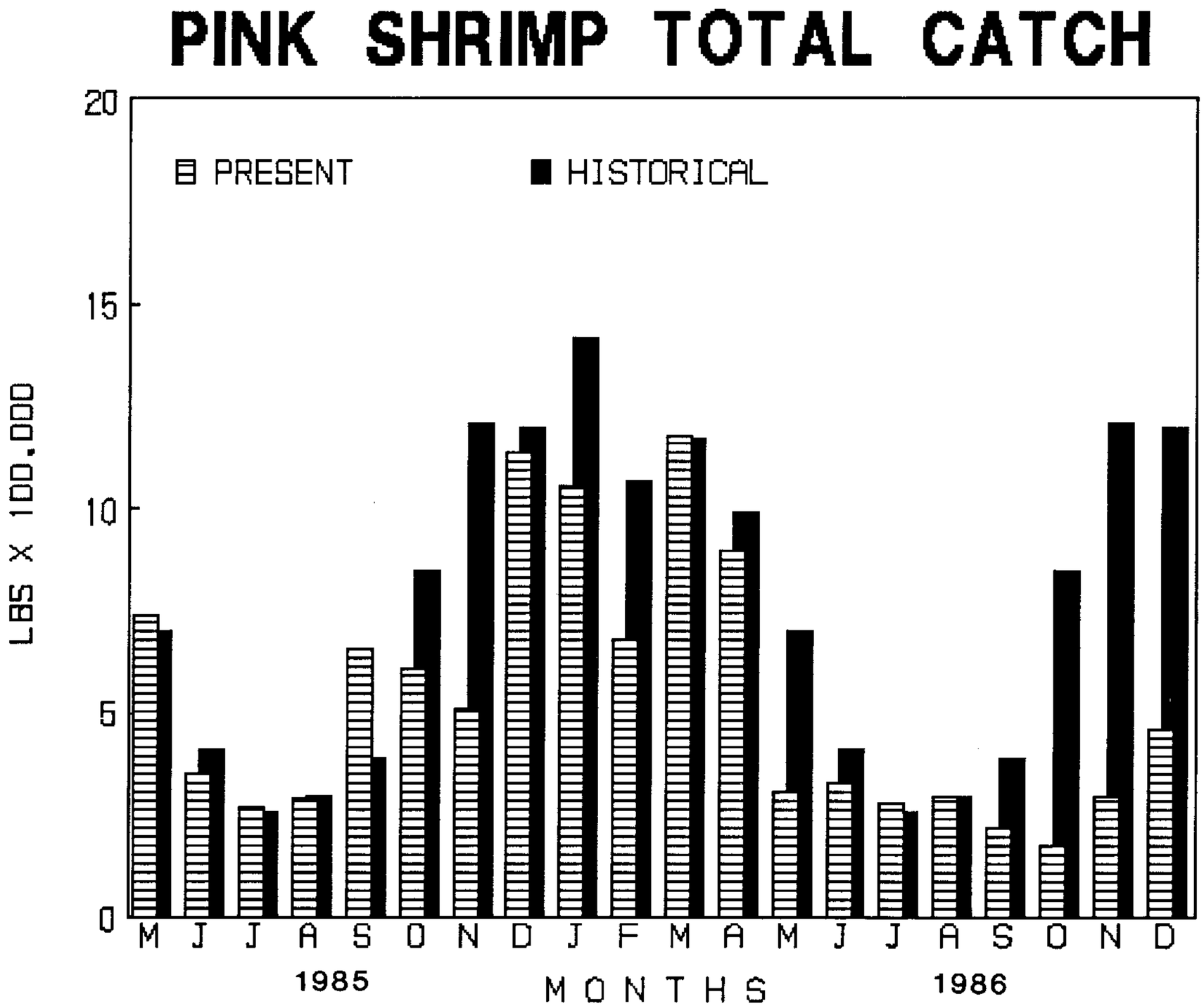

Figure 3. Average monthly historical catch compared to the catch from May 1985 through December 1986 taken on the Tortugas grounds (subareas 1 through 3).

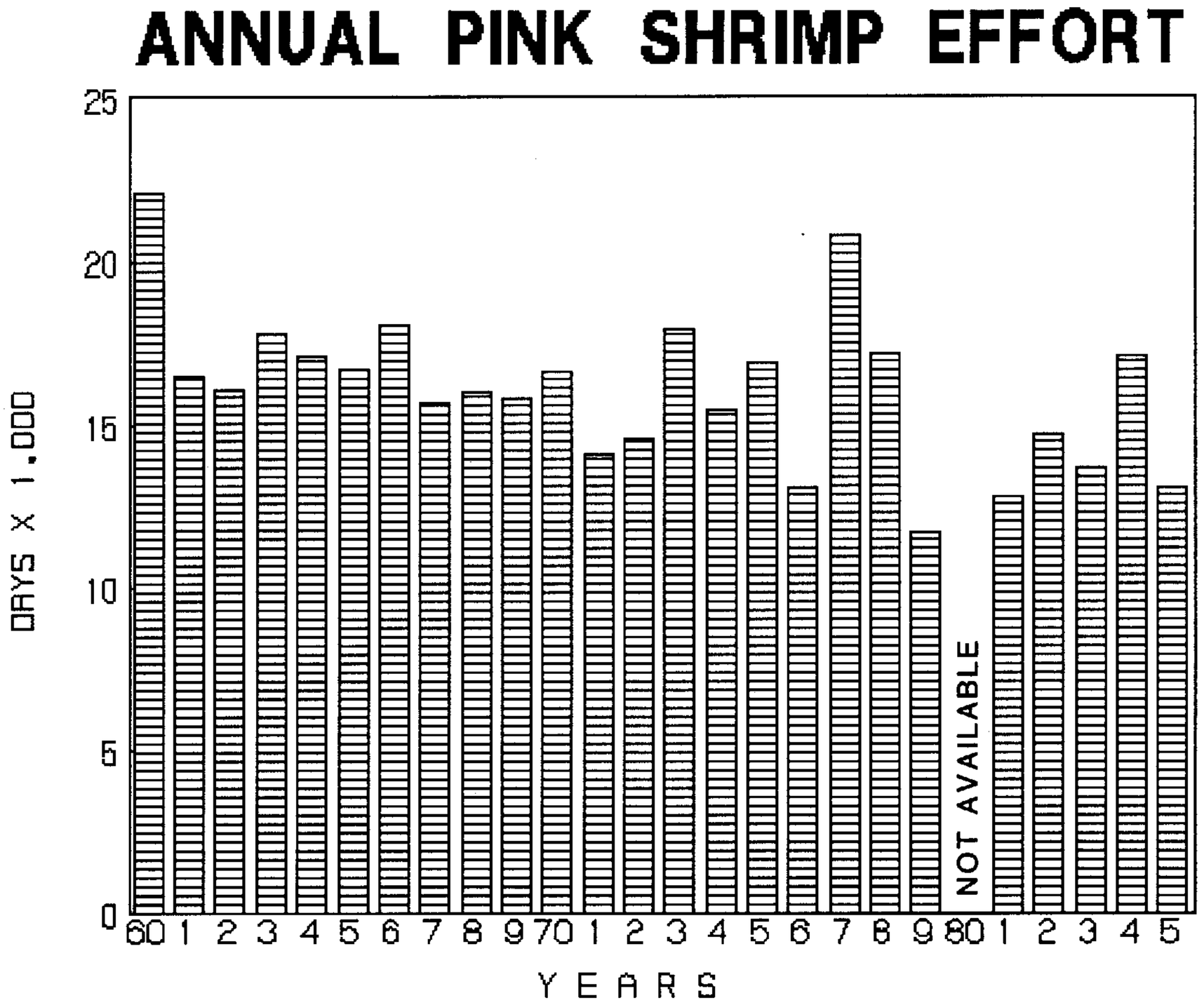

Figure 4. Pink shrimp fishery effort on the Tortugas grounds for biological years 1960 through 1985.

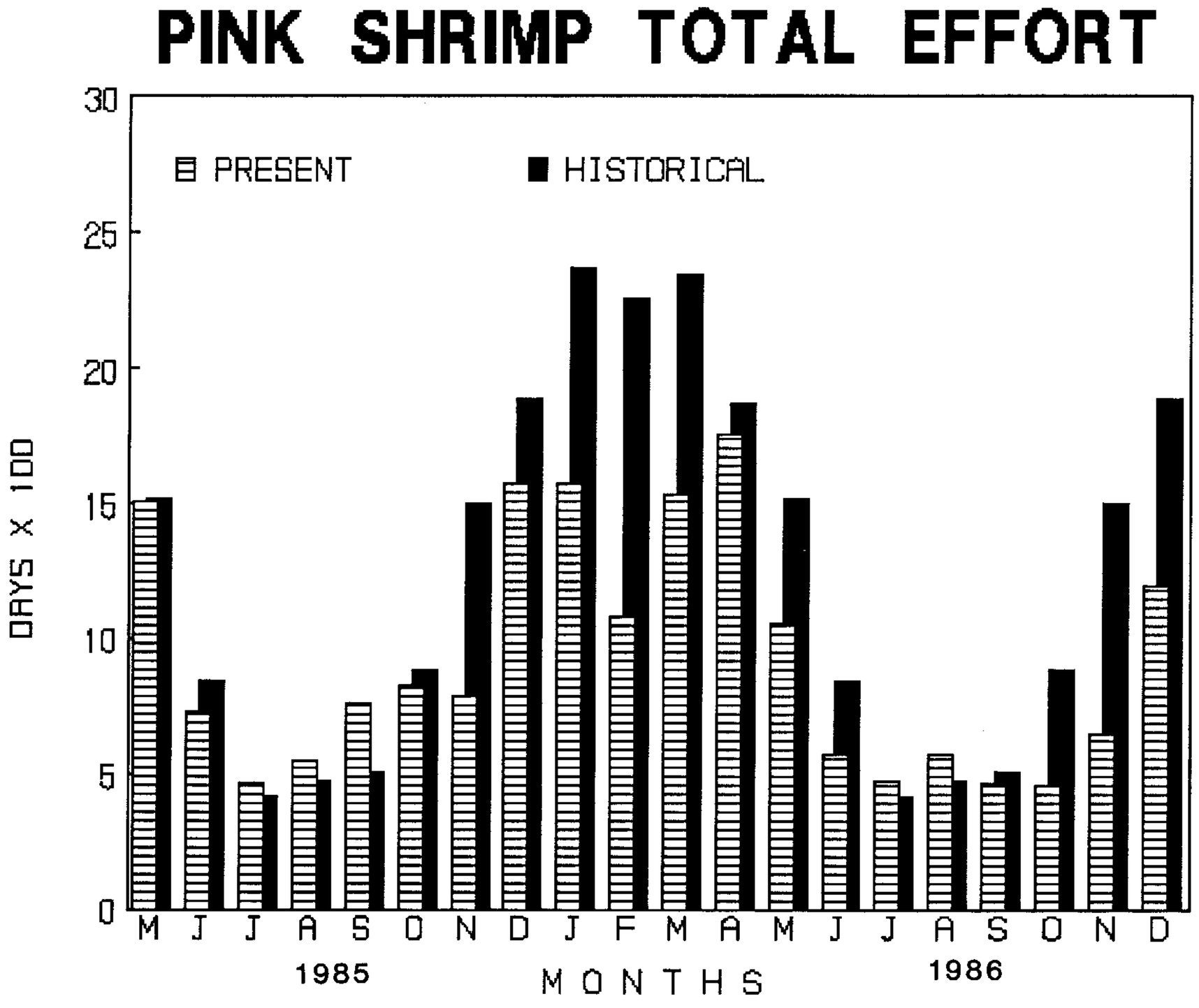

Figure 5. Average monthly historical effort compared to the monthly efforts for May 1985 through December 1986 from the Tortugas grounds.

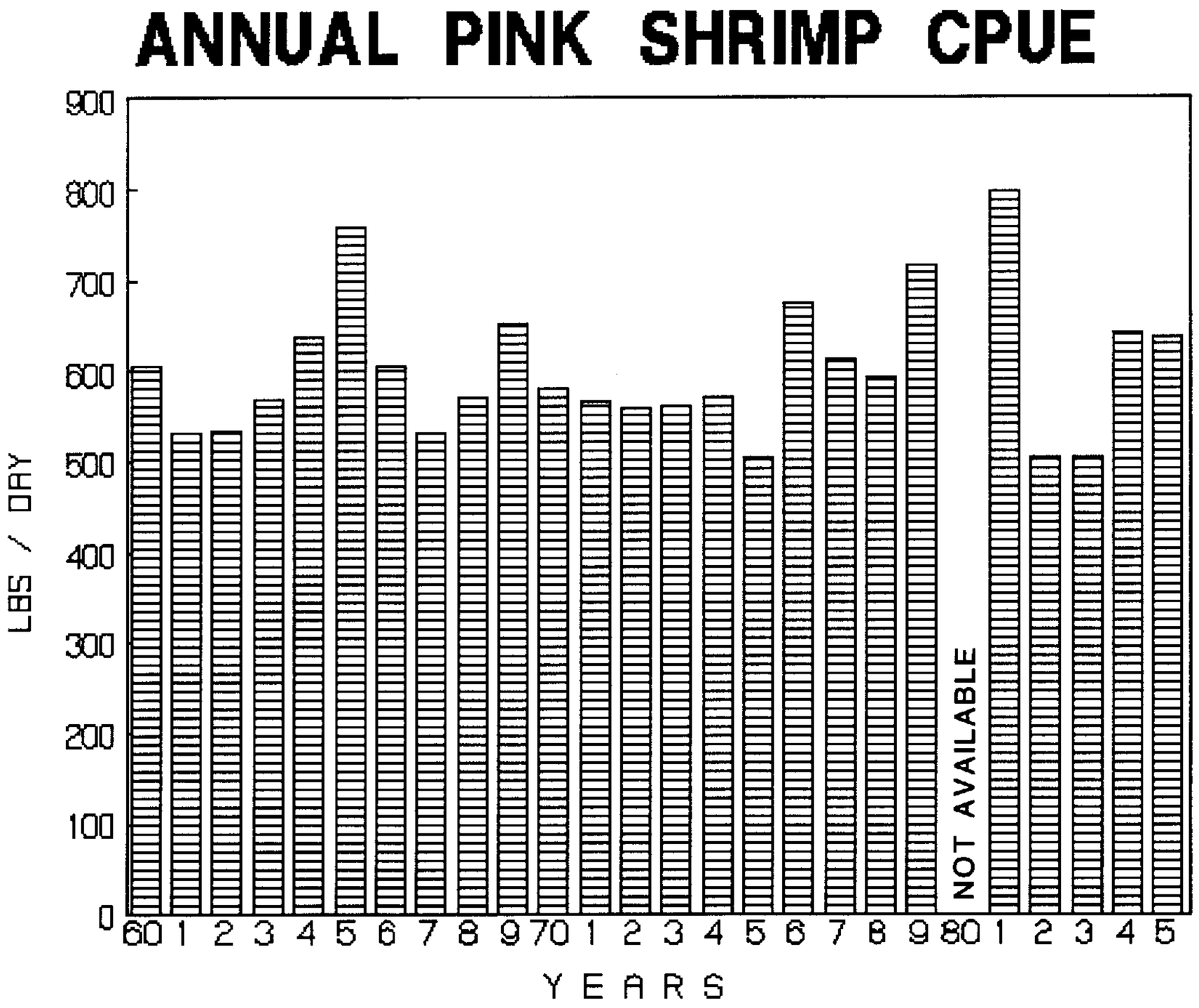

Figure 6. Catch per unit effort (CPUE) for biological years 1960 through 1985.

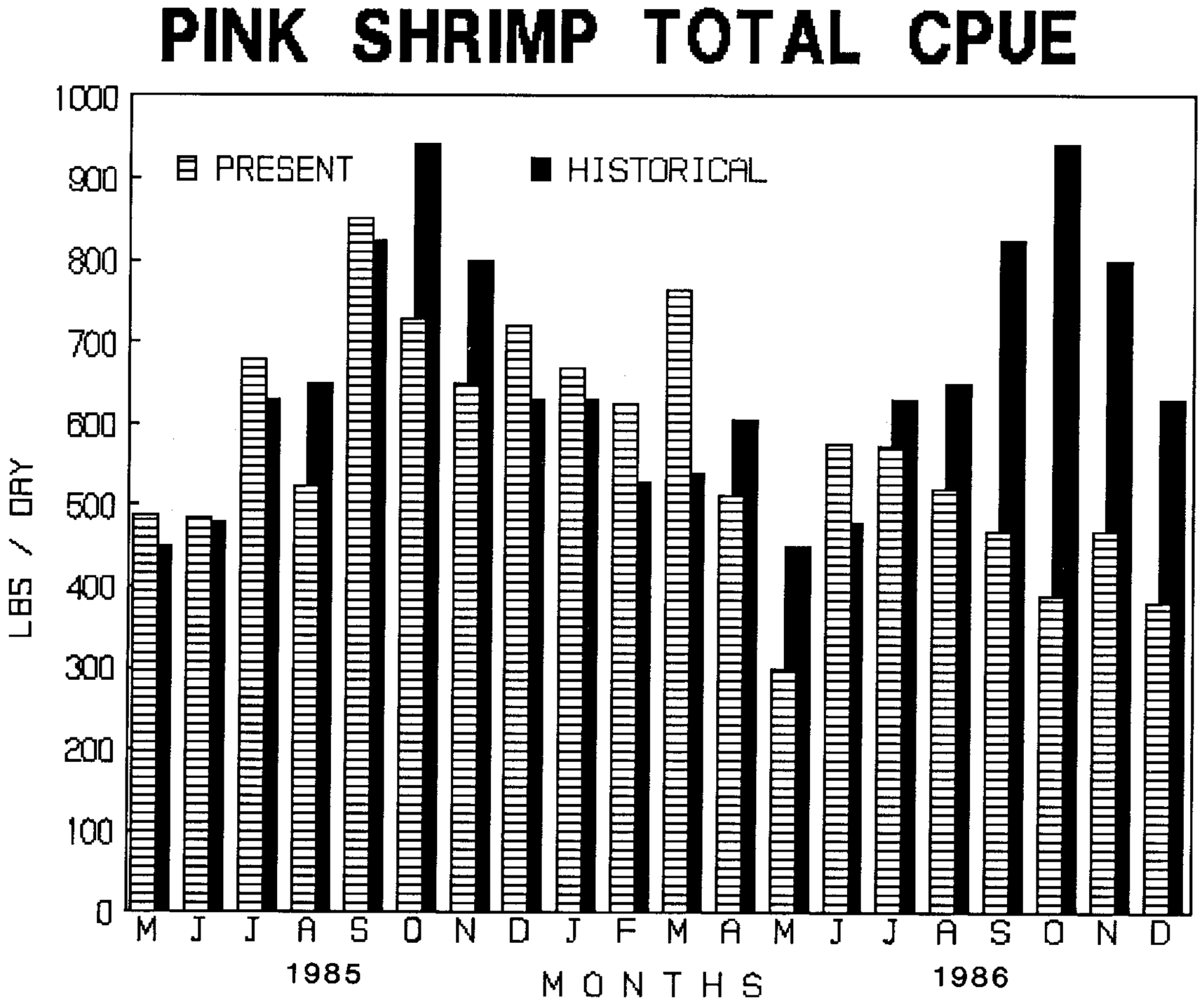

Figure 7. Average monthly historical CPUE values compared to the monthly CPUE values for May 1985 through December 1986 from the Tortugas grounds.

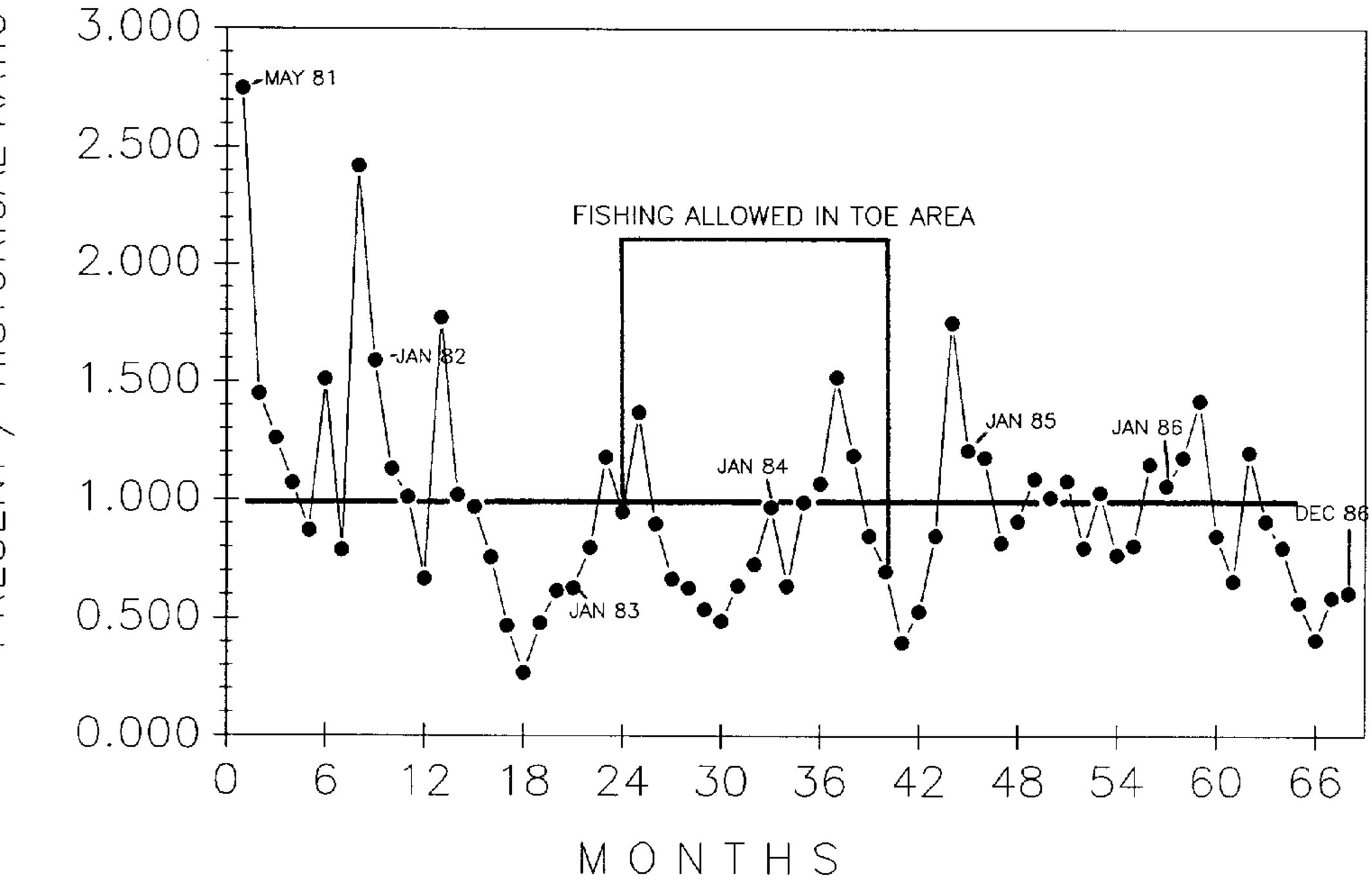

Figure 8. Ratios of monthly CPUE values from May 1981 through December 1986 compared with monthly historical CPUE values (1960 through 1979).

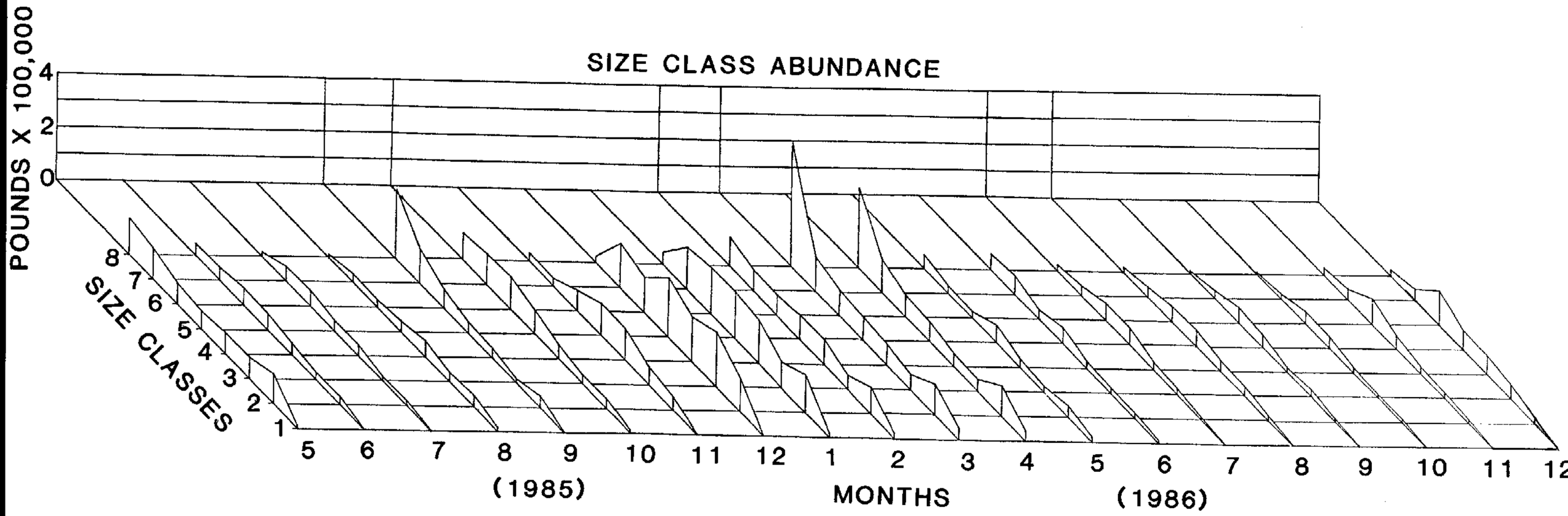

Figure 9. Total monthly catch by size classes from the Tortugas fishery for May 1985 through December 1986.

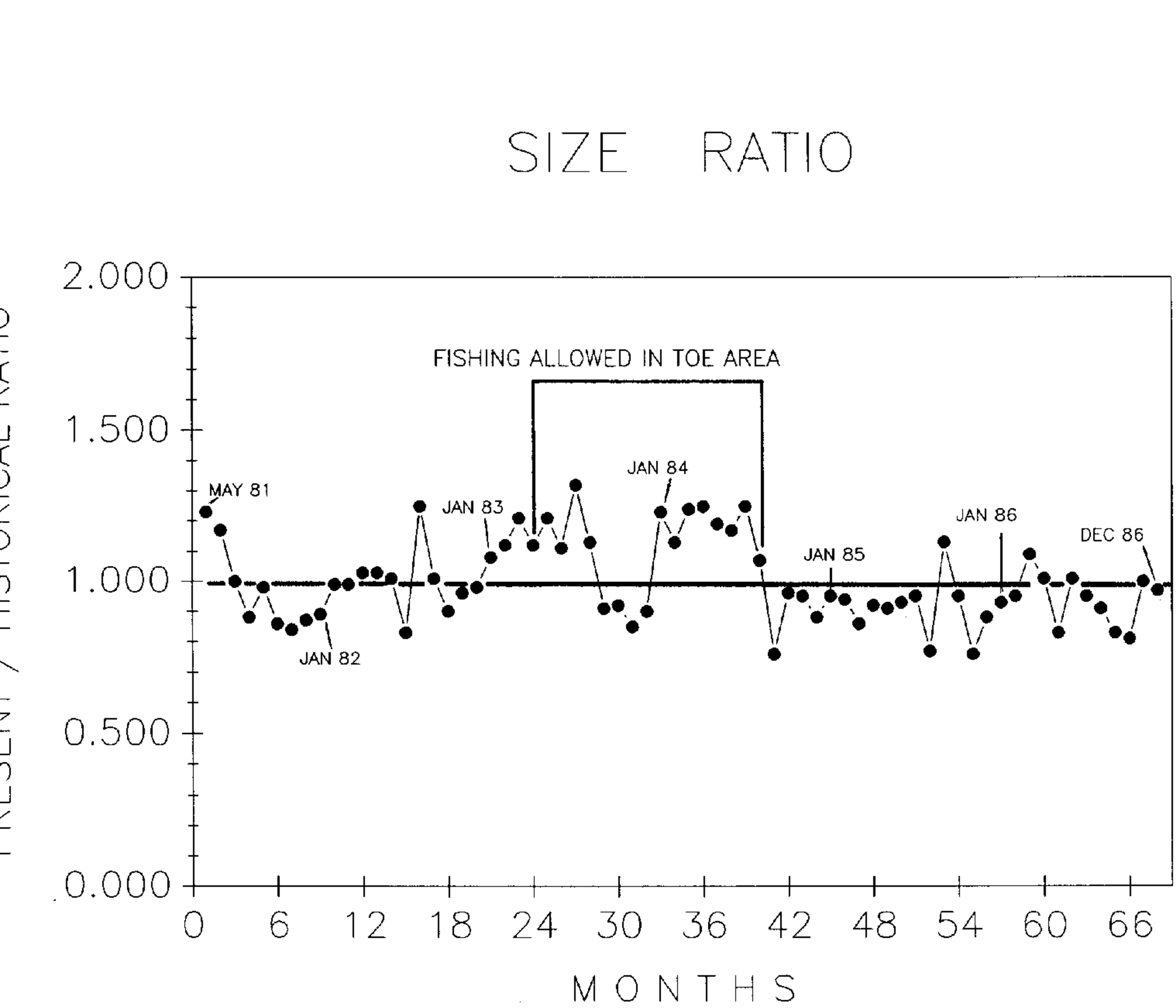

Figure 10. Ratios of monthly mean number of pink shrimp per pound from May 1981 through December 1986 to monthly historical mean number of pink shrimp per pound values (1960 through 1979).

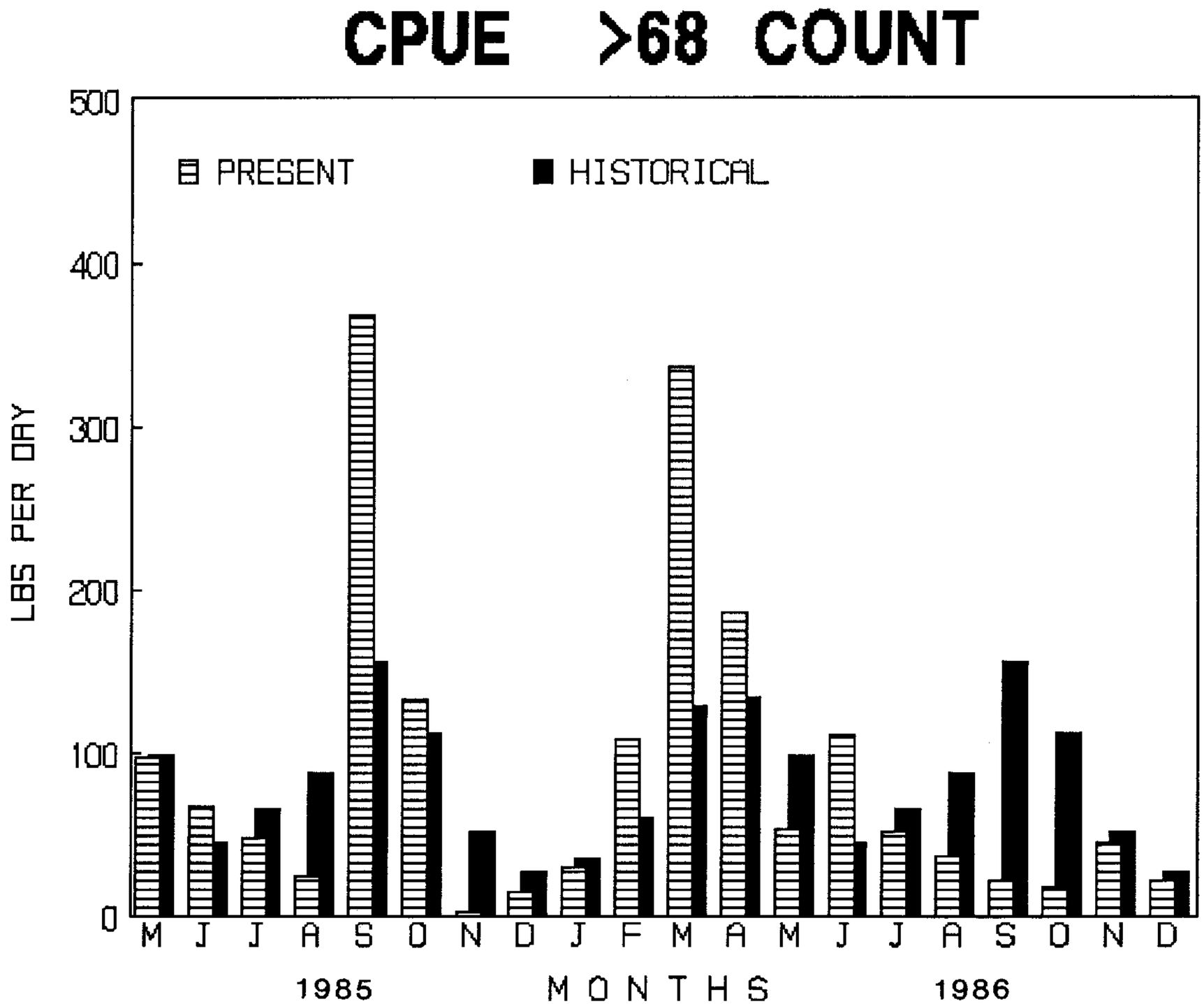

Figure 11. Average monthly historical CPUE values compared to the monthly CPUE values for May 1985 through December 1986, for shrimp >68 count.